AVS 254: Introduction to Animal Microbiomes

Instructor

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I do not have pre-scheduled office hours, but I am happy to meet.

Grader, contact for all questions about how things were graded:

Other help option: Help Discussion Forum: post questions anonymously on the Brightspace setup for the course, to be answered by the instructors, graders, or other students. This allows other students to see the answers, because usually many of you have the same questions.

Time, Location, and Mode of instruction

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Description of course and prerequisites

This course introduces students to host-associated microbiomes; the genomic collection of bacteria, archaea, fungi, protozoa, and viruses present in a host ecosystem. In each lecture, we will focus on an anatomical location, and discuss the host and environmental pressures which select for the resident microbial community. The material is primarily about animals (mammals, birds, fish, amphibians) but includes some human-specific comparisons. This course will introduce ecological theories (e.g. environmental selection, neutral theory) in the context of microbial communities, the history of host-associated microbiology, and how technology has contributed to or limited our understanding of organisms and their critical role in our health and development. The skill-set objectives include group discussions, reading scientific literature, and scientific writing in a variety of styles and both technical and non-technical formats.

Credit Hours: 3
Prerequisites: BIO 200 or BIO 208 or BMB 155 or BMB 280 or SMS 201; or permission
General Education requirements satisfied: Environment and Sustainability

Course materials and digital services used.

- Textbook: There is no required textbook for this class.
- Lecture recordings: All lectures are recorded, and audio-only and video files are provided at the beginning of the semester on Brightspace /Kaltura. Lecture slides: All lectures are provided at the beginning of the semester as pdfs with annotated speaker notes included as comments in the document. These will be updated as needed with corrections.
- Readings: Reading material will be provided as electronic journal articles, reports, or blogs.
- Discussions: There are several topics for reflection and open discussion, either in class or online as a forum post with the option of making it anonymous. These are optional and not graded.
- Assignments: All assignments can be submitted through Brightspace, and each assignment portal has more detailed instructions, grading rubrics, and the proposal assignment has an optional document template.
- Brightspace Online Learning Software
  - Log into Brightspace. Read the tutorial. Download the Pulse app.
  - Brightspace is the online learning management system used at UMaine. In our course Brightspace site, you will be able to access course materials, assignment descriptions, this syllabus, and the course schedule. You will submit your work through Brightspace and will be able to access your grades and feedback. You can download a "Brightspace Pulse" app for most mobile devices, but some functions in Brightspace work better when accessed through a laptop/desktop than through a mobile device. Support for the website and mobile apps includes video tours, IT Help Desk, and other resources. If you continue to have problems with Brightspace, please let me know as soon as possible.
  - If you wish to retain a personal copy of course materials, please do so before the end of the semester. **You will not have access to a course's Brightspace site after you complete the course.** You can store copies of material you wish to retain on Google Drive, your hard drive, or other media of your choosing. Other materials posted by your faculty may be found at the library.

I am happy to provide accommodation to the way course materials are formatted or provided to make them easier to access and understand. Please let me know if you have suggestions to improve the course materials.

Course Goals

- Introduce concepts, techniques, historical background, terminology, and technology of microbial ecology.
- Familiarize students with online resources, including sequence and other databases.
- Discuss factors which shape host-associated microbiomes and how the microbiome can affect the host.
- Review current literature on host-associated microbial ecology.

Student Learning Outcomes

As a result of taking this class, students will be able to:

- Describe the dynamics which shape host-associated microbiomes.
- Access online databases of scientific articles and databases.
- Review scientific journal articles and distill their findings while understanding their limitations.
- Communicate science in a variety of formats.
- Discuss topics related to science, such as recognition for achievements and the role of scientists in communicating results to the general public.

Environment and Sustainability Gen Ed Learning Outcomes

- Describe how host-associated microbial ecosystems are affected by environmental (external to the body) conditions.
- Describe how climate change affects range and diet selection, and how this can impact gut microbial communities and animal survival.
- Describe vertical and horizontal transmission, as well as environmental exposure of microorganisms.
- Describe the effect of pollution and air quality on health and the microbiome.
- Describe technical and/or scientific approaches for remediating environments using microbial communities, or remediating microbial communities using environmental factors, to address problems that arise in the relationship between human consumption and the environment.

Expectations of students and university policies

Attendance and Participation

You *should* attend every class, because you paid for this learning opportunity and *being present in class helps you learn* – even when you are tired and stressed. But, I understood that life, jobs, or farm work might prevent you from getting to class. To help, I have recorded lectures to help you keep up with materials. If you miss a significant number of classes, or if you require additional accommodation because you can't make class, please contact me to make alternate arrangements. If you are lactating or caring for young children you may bring them to class (see section on Pregnancy, lactation, and parenting).

I encourage you to participate in discussions in class, or on Brightspace, because peer-to-peer interaction really helps you learn. I strive to create inclusive discussions, but that's hard to do with so many students, so let me know how I could make space for you to participate. Supporting inclusion and community is an active process that involves both invitation, and support to ensure that the learning community is and remains an equitable and inclusive place. I expect you to be encouraging to other students in class so we can help each other learn.

Course Schedule Disclaimer (Disruption Clause): In the event of an extended disruption of normal classroom activities (due to COVID-19 or other long-term disruptions), the format for this course may be modified to enable its completion within its programmed time frame. In that event, you will be provided an addendum to the syllabus that will supersede this version.

Late Assignments

- Brightspace automatically enters 0 for all missing assignments at the due date – if it shows you submitted but you still got a 0, it did not upload correctly, so upload again with a note and we will regrade it.
- **I will accept assignments up to 24 hours after the posted due date with no penalty. After 24 hours, a more difficult version of the assignment rubric will be applied for some assignments, and you have until the last day of finals (Friday) to submit.**
- You can always submit late assignments, even if you received a 0. You will not receive a grade reduction for late assignments, but you waive the right to receive feedback which might impact the quality of successive assignments and your next grade.
- **Assignments will not be accepted after the last day of classes without medical or personal excuse, SAS accommodations, or instructor permission.**

Campus Policies

"The University of Maine System is an equal opportunity institution committed to nondiscrimination." Follow the links for more information.

Course Schedule Disclaimer*
Observance of Religious Holidays/Events*
Sexual Discrimination Reporting (Long)*
Sexual Discrimination Reporting (Short)*
UMaine Land Acknowledgement

Academic Honesty Statement* I use Turnitin to assess if you understand the material by your ability to explain in your own words. Assignments with a high score may be revised and resubmitted. You MAY NOT use AI to write their assignments, but you may use grammar/spellchecking.

Students Accessibility Services (SAS) Statement

I do my best to make course materials accessible with or without a referral from SAS. Please let me know if there are changes I can make to the materials. All lecture PowerPoints and assignment instructions are provided in advance, and recordings provided after lectures. I can provide audio instructions for all assignments. Students Accessibility Services Statement* If you have a disability for which you may be requesting an accommodation, please contact Student Accessibility Services, 121 East Annex, um.sas@maine.edu, 581.2319, as early as possible in the term. Students may begin the accommodation process by submitting an accommodation request form online and uploading documentation.

Assignments: Detailed instructions and rubrics on Brightspace.

Instructions, grading rubrics, and assignment submission are on Brightspace, but may be submitted to me on paper. Assignments can be improved/modified and reused throughout the semester as students build on what they know. All assignments must be written in your own words, so please don't use AI because it really doesn't know anything about microbiomes. If the assignment is written by AI, you will not receive a grade. You are allowed to use some quotes in your written assignments.

- **Post-lecture comprehension quizzes (28):** After each lecture, there is a short quiz to test your comprehension of the learning objectives.
- **Bonus Seminar Summaries:** To obtain up to 6 bonus points total, write a 1-paragraph (~200 words) summary of a seminar on microbiology/microbiomes. Suggestions are provided on Brightspace.

Grading (out of 100 points): Post-lecture Comprehension Quizzes (27 x 1 point each). Weekly Assignments (14 x ~5 points each). Bonus Seminar summaries, 2 pts each and up to 6 points. Points in the grade are additive, so to achieve a passing grade you need to accumulate enough points. A = 93–100; A– = 90–92; B+ = 87–89; B = 83–86; B– = 80–82; C+ = 77–79; C = 73–76; C- = 70–72; D+ = 67–69; D = 63–66; D- = 60–62; F = 0–59.

Schedule of lectures (~2/week) and assignments (~1/week)

Week	**Title, Objective, Assignments** **The playlist for recorded lectures is: https://video.maine.edu/playlist/dedicated/1_nymvn48e/**
1	*Lecture 0 "Intro to the course"*, explanation of the syllabus and course expectations, materials.
Week 1 08/31 – 9/4 Class on 8/31	*Lecture 1 "What is a host-associated microbiome?"* (47 min) An introduction to what a host-associated microbiome actually is. ➢ **Post-lecture quiz** ➢ **Reading after lecture (choose 1)**: ○ Gilbert_2014_life in a world without microbes ○ Ishaq_2019_microbes and social equity
	Lecture 2 "A brief history on the discovery of microorganisms." (44 min) The discovery of microorganisms, historical perspective, development of theories. ➢ **Post-lecture quiz** ➢ **Reading (choose 1)**: ○ Caumette_2015_Historical elements of microbial ecology ○ DAbramo_2020_historical_epistemiology_microbes ○ Opal_2010_brief_history_micro_immunology
	Assignments from week 1 due Friday at 9 am: ➢ **Post-lecture comprehension quizzes on Brightspace (1 pt each)** ➢ **Quiz on Brightspace (2 pts):** "Syllabus". Answer questions about info in the syllabus. No time limit, you can take it twice. ➢ **Host Microbe Playlist Assignment (2 pts)**: choose 2 songs to add to the Host-Microbe Interactions Playlist Discussion Topic on Brightspace. ➢ **Interactive Lab Assignment (2 pts):** Play in the Interactive Bacterial Identification Lab! Click through the animations to overview DNA extraction PCR, culturing, and identification. Then, submit a short paragraph to Brightspace explaining one of the techniques that you learned. https://www.biointeractive.org/classroom-resources/bacterial-identification-virtual-lab
Week 2 9/7 – 9/11 No Class! Monday is Labor Day	*Lecture 3* "*Through the looking glass.*" (30 min) Microbial visualization techniques, stains, fluoroscopy, SEM/TEM, RAMAN. ➢ **Post-lecture quiz** ➢ **Microscope explanation videos (optional):** ○ https://www.youtube.com/watch?v=hGczLc4167U ○ https://www.youtube.com/watch?v=gzYIE6MsSRo ➢ **Reading after lecture (choose 1)**: ○ Emerson_2017_live_or_dead_cells ○ Valm_2012_CLASI-FISH
	Lecture 4 "DNA and sequencing technology changed our view of the world." (1 hour) Discovery of DNA, using it to understand microbes, sequencing technology, going from studying one species in a culture to thousands of species in a dataset. ➢ **Post-lecture quiz** ➢ **Readings after lecture (do this one first)**: ○ "A journey through the history of DNA sequencing", ~1500 words ➢ **Readings after lecture (choose 1 of these, too):** ○ Maheshwari_2024_sequencing_tech_human_gut ○ Porath_Krause_2021_amplicon_sequencing_ecologyanda_2007_16S ○ Any of the sequencing technology submodules on Brightspace, watch the videos (~10 min total), and read the paper for that technology
	Assignments from week 2 due Friday at 9 am:

	➢ **Post-lecture comprehension quizzes on Brightspace (1 pt each)** ➢ **Microbes and Technology Assignment (5 pts).** First, draw a concept map of how some of these technologies fit together. Then, write out how technology can be used to find specific info on microbes. What technology can be used to find out what microbes eat/metabolize, what products they make, what they look like, what genes they have, which genes they are actually using? What things are measured by each technology, or what do you look for as a researcher? Come up with a research question/scenario about trying to find or visualize microbes in any location or host. Describe what technology you might use and why. You may set this in modern times or historical times. Include any references you used. Text should be ¾ page, or >1 page if submitted >24 hours late. Detailed instructions on the assignment portal.
Week 3 9/14 – 9/18 Class on 9/14	*Lecture 5 "Phylogeny and understanding microbial diversity."* (31 min) How do you define a microbial species when they trade DNA easily and act differently based on their environment? Learn how microbes are classified and what it means to be a species. ➢ **Post-lecture quiz** ➢ **Reading after lecture**: Hugenholtz_2021_prokaryotic_taxonomy
	Lecture 6 "The oral microbiome." (45 min) Bacteria in the mouth are affected by salival production, and have systemic health effects. ➢ **Post-lecture quiz** ➢ **Reading after lecture (choose 1, or one of your choosing on oral microbiomes)**: ○ Barden_2020_oral_microbiome_calves ○ Borsanelli_2018_cow_periodontis ○ EmamiKhoyi_2020_oral_microbiome_possums_stoats_NewZealand ○ Dudek_2017_oral_microbiome_marine_mammals ○ Proctor_2017_nose_mouth_throat_humans ○ Ruparell_2020_canine_oral_microbiome
	Assignments from week 3 due Friday at 9 am: ➢ **Post-lecture comprehension quizzes on Brightspace (1 pt each)** ➢ **Going from DNA to Ordination Plot Assignment (3 pts):** Use the walkthrough to learn how to hand-align short DNA sequences, use them to calculate genetic distance, and use the distance numbers to draw simple ordination plots and phylogenetic trees. ➢ **Learn NCBI Assignment (3 pts):** Use the walkthrough to learn how to use NCBI databases to find DNA sequence information, make alignments, and assess relatedness of similar microbes.
Week 4 9/21 – 9/25 Class on 9/21	*Lecture 7 "Monogastrics and gut microbiome."* (40 min) Anatomy and the gut microbiome of monogastrics, a comparison of animal species. ➢ **Post-lecture quiz** ➢ **Reading after lecture (choose 1, or another on monogastric gut)**: ○ Jing_2020_insect_gut_microbiome ○ Kauter_2019_horse_gut_microbiome ○ Moeller_2014_human gut microbiome ○ MoisselEichinger_2018_archaea_animals ○ Nakagawa_2017_starfish_gut_microbiome ○ PachecoSandoval_2019_harbor_seal_gut ○ Wasimuddin_2016_cheetah_gut
	Lecture 8 "Gut microbiota of birds." (40 min) The unique digestive tract of birds, their gut microbiota, bats vs. birds vs. mammals. ➢ Post-lecture quiz ➢ **Reading after lecture (choose 1, or any other on bird microbiomes)**: ○ Martinez-Garcia_2016_nest_microbiome_eggs ○ Oliveira_2020_raptor_microbiome ○ Price_2015_digestion and aerial lifestyle

	○ Dissertation defense, "The Effect of Nest Architecture on Nest Microclimate and Microbiome Assembly in Tropical Birds"
	Assignments from week 4 due Friday at 9 am: ➢ **Post-lecture comprehension quizzes on Brightspace (1 pt each)** ➢ **Quiz on Brightspace (4 pts):** "Plagiarism". Answer questions on how to cite other people's ideas in your scientific writing. No time limit, you can take it twice. ➢ **Migration and Microbiomes (4 pts):** First, use the Migratory Bird Tracker from the Audubon Society to find a species of migratory bird https://explorer.audubon.org/home?layersPanel=expand. This review paper will be helpful, too: https://nsojournals.onlinelibrary.wiley.com/doi/10.1111/jav.03406. You can also choose a mammal or other animal that is known to migrate, but it might be more difficult to find information on those. Second, describe two of the geographic locations that the animal travels to, and some details on the environmental conditions or diet there. Third, try to find a gut microbiome paper (or use that review) on that species, and discuss some of the results they found. Include any references you used. Text should be 1/2 page, or >3/4 page if submitted >24 hours late. Detailed instructions on the assignment portal.
Week 5 9/28 – 10/2 Class on 9/28	*Lecture 9 "Ruminants."* (112 min) The rumen microbial community, and its importance to the herbivore. ➢ Post-lecture quiz ➢ **Reading after lecture (choose 1, or any other on ruminant microbiomes)**: ○ Henderson_2015_core rumen microbiome ○ Huws_2018_rumen_microbiome_agriculture ○ Ishaq_2015_prot methanogen moose ○ Jonge_2022_gut_microbiome_mammals ○ Thomas_2022_gut_archaea_mammals ○ Williams_2019_wildlife_microbiomes ○ Yan_Yu_2024_rumen_viruses
	Lecture 10 "Effect of diet on the gut microbiome." (45 min) Specific nutrients in a diet, or food preparation, create nuances in the gut microbiome. ➢ Post-lecture quiz ➢ **Reading after lecture (choose 1, or any other on diet and gut microbiomes):** ○ Hadadi_2021_gut_microbes_micronutrients ○ Harris_2019_gutmicrobiome_diet_parasites ○ Kearney_2018_seaweed_and_probiotic ○ Vangay_2018_immigration_gut_microbiome
	Assignments from week 5 due Friday at 9 am: ➢ **Post-lecture comprehension quizzes on Brightspace (1 pt each)** ➢ **What Big Teeth You Have Assignment (5 points)**: Choose any animal, and write about how their teeth/oral anatomy is tied to their diet, and what the major components of that would be (ex. Fat, protein, fiber). Include a photo of the teeth. Then find at least two journal articles on that animal species and how their diet impacts their gut microbiome. Explain what technology they used, and summarize the results. List the questions that you still have even after reading these papers, what else would you want to know about this animal, diet, and the microbiome? Include any references you used. Text should be ¾ page, or >1 page if submitted >24 hours late. Detailed instructions on the assignment portal.
Week 6 10/5 – 10/9	*Lecture 11* "*The many benefits of fiber.*" (53 min) How fiber affects gut microbiota, including carnivores, the curious case of the panda. The effect of lack of fiber (rumen acidosis) in wild and domesticated animals, and microbial therapeutics. ➢ Post-lecture quiz ➢ **Reading after lecture (choose 1, or any other on fiber and gut microbiomes)**:

Class on 10/5	○ Felton_2017_wild_ungulates_acidosis ○ "Inuit Fermentation: Animal-based & Archaic with Aviaja Hauptmann", https://www.youtube.com/watch?v=NZiiu34dF5Y&ab_channel=AppliedEcology ○ Ishaq_2017_rumen_microbes_SARA ○ Slavin_2013_fiber_health ○ Sonnenburg_2014_microbial_accessible_cabohydrates ○ Zhao_2018_fiber and diabetes
	Lecture 12 **"***I don't need that kind of toxicity in my life.*" (38 min) How gut microbes detoxify plant-secondary compounds and drugs. ➢ Post-lecture quiz ➢ **Reading after lecture (choose 1, or any other on diet toxins and gut microbiomes)**: ○ Coolen_2014_bug_microbes_detoxify_crops ○ Dearing_2022_gut_microbes_detoxify_for_herbivores ○ Kohl_2016_woodrats and toxins ○ Wilkinson_2018_microbiota drug interactions ○ Zhang_2014_gut_microbes_detoxify_invasive_moth
	Assignments from week 6 due Friday at 9 am: ➢ **Post-lecture comprehension quizzes on Brightspace (1 pt each)** ➢ **Learn to use CAZyme Assignment (3 pts):** Follow the walkthrough on Brightspace to check out the CAZYME database. ➢ **Gut Microbe Research Assignment (5 pts):** First, choose any animal species and draw the GI tract anatomy (or find a diagram to annotate), label the major organs, add at least 2 interesting features like pH or special enzymes in each organ that would affect the gut microbes. Next, come up with a way to sample microbes from hard-to-reach locations in the gut (no feces allowed, try to get into the middle of the GI tract) without harming the animal. Describe what technology you might use and why. You may use existing technology or brainstorm new technology. Include any references you used. Text should be 1/2 page, or >3/4 page if submitted >24 hours late. Detailed instructions on the assignment portal.
Week 7 10/12 – 10/16 No class, 10/12 - 10/13 is Fall break	*Lecture 13 "Vaginal microbiome"* (30 min) The vagina, drivers of the microbiome, comparisons across primates, and studies on smoking. ➢ Post-lecture quiz ➢ **Reading after lecture (choose 1, or any other on vaginal microbiomes)**: ○ Lyman_2018_canine_vaginal_endometrial_microbiome ○ Matějková_2020_field_mice_vaginal_microbiome ○ Messman_2021_bovine_vaginal_microbiome ○ Miller_2016_comparison_vaginal_microbiome ○ Nelson_2018_smoking_vaginal_microbiome ○ Zhang_2020_panda_vaginal_microbiome ○ Zhao_2022_Lactobacillus_moth_reproductive_tract
	No additional lecture, vacation week
	No assignments, vacation week
Week 8 10/19 – 10/23 Class on	*Lecture 14 "Coprophagy and early-life microbes."* (30 min) Coprophagy and why rabbits recycle, bats feces and humans don't mix, dung beetles are helpful, and the benefits and drawbacks of the "cage effect" in mice and zebrafish. ➢ Post-lecture quiz ➢ **Reading after lecture (choose 1, or any other on coprophagy and microbes):** ○ Bottino_2025_early_life_succession_humans ○ Jahnes_2018_coprophagy_cockroaches ○ Wang_2023_coprophagy_rabbits ○ Videvall_2023_coprophagy_birds

10/19, taught by Ashley Reynolds	*Lecture 15* "*Vertical transmission of microbes in eggs or pregnancy.*" (55 min) Transmitted microbes on eggs, to larvae, pregnancy changes to microbiome, *in utero* transfer, and the effect of stress during pregnancy on parental and offspring microbes. ➢ Post-lecture quiz ➢ **Reading after lecture (choose 1, or any other on pregnancy or egg microbiomes)**: ○ Bjork_2019_vertical_transmission_sponges ○ Bunker_2021_egg_maternal_bacteria_lizards ○ (Video) Jaserevic_microbiome_pregnancy_stress ○ Zhang_2021_developing_gut_neonate_ruminants
	Assignments from week 8 due Friday at 9 am: ➢ **Post-lecture comprehension quizzes on Brightspace (1 pt each)** ➢ **Baby's First Microbes Assignment (5 pts):** Pick any animal species and describe their birth first few weeks of life: were they gestated in eggs or in vivo? What kind of microbes might they be exposed to because of that? Do they receive maternal oral/gut secretions, feces, or milk, and what kind of microbes will they be exposed to? What do they usually eat in the first few weeks and what kind of microbes will they need to help them digest that? Include any references you used. Text should be ¾ page, or >1 page if submitted >24 hours late. Detailed instructions on assignment portal.
Week 9 10/26 – 10/30 Class on 10/26	*Lecture 16 "Vertical transmission of microbes by milk."* (45 min) Breastmilk and the development of the neonate GI microbiome, discussion of vertical transmission of microbes. ➢ Post-lecture quiz ➢ **Reading after lecture (choose 1, or any other on milk microbiomes):** ○ Keady_2023_milk_microbiomes_across_mammals ○ Me_2022_waste_milk_feeding_calf_health ○ Petrullo_2022_milk_microbiome_vervet_monkey ○ Power_2024_milk_microbiome_review ○ Yeoman_2018_effect of colostrum on calf rumen
	Lecture 17 "*Microbes and the nature vs. nurture debate.*" (48 min) Generational effects of microbes, and nature (host) vs. nurture (environment) in microbiomes. ➢ Post-lecture quiz ➢ **Reading after lecture (choose 1, or any other on nature/nurture microbiomes):** ○ Farmer_2025_population_descriptors_human_microbiome ○ Liu_2021_gut_microbiome_dogs_versus_wolves ○ Prabhu_2020_wild_domestic_bovine_microbiome ○ Rothschild_2018_nurture_over_nature ○ Wang_2018_rearing conditions in ducks ○ Yan_2016_env_filtering_fish_microbiome
	Assignments from week 9 due Friday at 9 am: ➢ **Post-lecture comprehension quizzes on Brightspace (1 pt each)** ➢ **Nature vs. Nurture Assignment (5 pts):** Pick any animal species and find one journal article on that animal in the wild and one on that animal in captivity. If you can't try to find two papers on that animal in the wild, or two in captivity, with different circumstances so you can compare them. Describe the animal, the ecosystem it usually lives in, and what it usually eats in its natural environment. Now describe the elements that are different in captivity (less plant biodiversity, coastal ocean water versus deep sea water, diet, etc.). How did the different circumstances lead to different microbes in that animal? Did the researchers try any interventions to help increase microbial diversity in captivity? Include any references you used. Text should be ¾ page, or >1 page if submitted >24 hours late. Detailed instructions on assignment portal.
Week 10	*Lecture 18* "*Probiotics, prebiotics, and synbiotics.*" (106 min) Do probiotics work? Federal regulations, assessment, and theory, in people and animals.

11/2 – 11/6 Class on 11/2	➢ Post-lecture quiz ➢ **Reading after lecture (choose 1, or any other on probiotics and microbiomes)**: ○ Delgadillo-Ordoñez 2024 probiotics for corals ○ Fijan 2014 microorganisms with claimed probiotic properties ○ Gorzelanna_2025_OneHealth_probiotics ○ Gupta_2016_FMT in perspective ○ Raabis_2019_probiotics_ruminants ○ Venugopalan_2010_regulations_safety_probiotics
	Lecture 19 "Host immune-microbe interactions in the gut." (50 min) GI tract microbiome and interactions with the epithelium and immune system, and how interactions here lead to systemic effects like allergies. ➢ Post-lecture quiz ➢ **Reading after lecture (choose 1)**: ○ Knoop_2020_breastfeeding_allergies ○ Lubin_2023_limiting_microbiome_limits_immune ○ Nyholm_ 2012_invertebrate_immune_microbe_interactions ○ Peng_2021_gut_microbes_mucosa_pigs
	Assignments from week 10 due Friday at 9 am: ➢ **Post-lecture comprehension quizzes on Brightspace (1 pt each)** ➢ **Probiotics Pros and Cons Assignment (5 pts)**: Locate a product labeled as "probiotic". Write down the product, the microbes used, and health claims included on the product. Choose one microbe, and search for 1 journal article that confirms that microbe's health benefits, and explain the experiment they used and how they assessed a positive impact (reduction in symptoms? More cell growth? Etc.) Search for 1 journal article that refutes that microbe's health benefits, and explain the experiment they used and how they assessed a negative or no impact. If you can't find a paper refuting the claims, choose a second article that supports the health claims and compare the two papers. What circumstances were different between the studies that might account for difference in outcomes? Include any references you used. Text should be ¾ page, or >1 page if submitted >24 hours late. Detailed instructions on assignment portal.
Week 11 11/9 – 11/13 Class on 11/9	*Lecture 20 "Intestinal parasites and immune monitoring."* (42 min) Intestinal parasites and how they affect gut microbes, and origin of the Hygiene Hypothesis. ➢ Post-lecture quiz ➢ **Reading after lecture (choose 1, or any other on intestinal parasites and microbiomes)**: ○ Dunstand-Guzmán_2019_parasites_microbes_medicine ○ Harris_2019_gutmicrobiome_diet_parasites ○ Ishaq_nematode_ant_bacterial_transfer ○ Leung_parasite_microbes_ecology ○ Mamun_2020_parasites_bacteria_sheep ○ Scudellari_ 2017_cleaning up hygiene hypothesis
	Lecture 21 "Seasonal effects on the gut microbiome." (35 min) What happens to gut microbes when food is scarce, and what happens during hibernation? ➢ Post-lecture quiz ➢ **Reading after lecture (choose 1, or any other on seasonal effects on microbiomes)**: ○ Carey_2012_ground squirrel hibernation ○ Video: "Badger Talk: Hibernators and Their Microbes", Edna Chiang ○ Sommer_2016_brown_bear_microbiota ○ Wei_2021_seasonal_diets_yak_sheep ○ Wiebler_2018_urea_hydrolysis_hibernating_frog ○ Williams_2023_seasonal_gut_rhino
	Assignments from week 11 due Friday at 9 am:

	➢ **Post-lecture comprehension quizzes on Brightspace (1 pt each)** ➢ **Microbe Intervention Research (5 pts):** First, pick any animal species or any disease and draw a concept map on the factors/microbes which are different between a healthy or disease state in that animal (or in that disease in general). Next, describe how you would create an intervention to either improve that animal's microbial exposure (environment, diet, etc.) or design a probiotic/microbial therapeutic treatment, to treat that disease. What would you use, how would it work on the host's microbes? Include any references you used. Text should be ¾ page, or >1 page if submitted >24 hours late. Detailed instructions on assignment portal.
Week 12 11/16 – 11/20 Class on 11/16	*Lecture 22 "Factors driving the skin microbiome."* (43 min) Skin microbiota of humans, terrestrial mammals, and aquatic mammals. ➢ Post-lecture quiz ➢ **Reading after lecture (choose 1, or any other on skin microbiomes)**: o Boxberger_2021_human_skin_microbiome o DeCandia_2019_mange_microbes o Kong_2017_skin microbiome o Ross_2019_skin_microbiome_vertebrates
	Lecture 23 "Skin microbiota of amphibians and health." (38 min) Amphibians' skin connects them to the environment – for better or worse. ➢ Post-lecture quiz ➢ **Reading after lecture (choose 1, or any other on amphibian skin microbiomes):** o BritodeAssis_2017_skin microbiota frogs o Brucker_2008_amphibian_bacteria_antifungals o Greenspan_2017_climate_infection_vulnerability o Hernández-Gómez_2020_AmphibianSkinMicrobiota o Pounds_2006_climatechange_extinction
	Assignments from week 12 due Friday at 9 am: ➢ **Post-lecture comprehension quizzes on Brightspace (1 pt each)** ➢ **What Big ears You Have Assignment (5 pts):** Choose any animal and describe its skin/fur/exoskeleton, local environment, and what factors might affect their external microbiome. Describe their skin/surface microbiome. Include any references you used. Text should be 1/2 page, or >1 page if submitted >24 hours late. Detailed instructions on assignment portal.
Week 13 11/24 – 11/28 No Class 11/25 – 11/29 T-day	*Lecture 24* "*Aquatic invertebrates affected by environment and microbes*" (1 hour) Lobster shell bacteria and lobster health are affected by warming water, and differences in microbial acquisition in wild scallop larvae versus hatchery scallop larvae. ➢ **Post-lecture quiz** ➢ **Reading after lecture (choose 1, or any other on marine animal microbiomes):** o Ishaq_2023_lobster_shell_disease o Ishaq_2023_scallop_bacterial_communities o Liu_2020_gut_microbes_scallops_carotenoids o Miller_2020_whale_gut_microbiome o Osvatic_2021_chemosynthetic_symbionents_sponges o Rojas_2019_Vibrio_scallops_Chile o Yu_2019_healthy_diseased_Yesso_scallops
	No additional lecture, vacation week
	No assignments, vacation week
Week 14	*Lecture 25* "Lung microbiome and air quality." (51 min) Environmental microbial diversity, cloud microbiomes, and transmission of epidemics in dust. ➢ Post-lecture quiz ➢ **Reading after lecture (choose 1, or any other on lung microbiomes):**

11/30 – 12/4 Class on 11/30, taught by Ashley Reynolds	○ FillionBertrand_2019_lung_bacteria_asthma_horses ○ Griffin_2007_desert dust and human health ○ Pirolo_2021_lung_bacteria_pigs ○ Rhodes_2022_breath_bacteria_orca_whales ○ Trinh_2018_microbes_humans_animals_environment ○ VientosPlotts_2019_canine_bacterial_pneumonia ○ Yagi_2021_lung_microbiome_healthy_disease
	Lecture 26 "Horizontal transmission." (53 min) Sharing microbes, cohabitation, and how transfer can be mediated by the built environment. ➢ Post-lecture quiz ➢ **Reading after lecture (choose 1, or any other on transfer of microbiomes)**: ○ Aguirre_2019_one_health_toxoplasmosis ○ Bai_2022_AMR_farms ○ (video) Howe_2025_AMR_farms_exploding_manure ○ Kilic_2021_AirQualityMeasurementsSheepBarns ○ Mhuireach_2022_grazing_soil_micobiomes ○ Rader_2021_masks_infection_control ○ Valles-Colomer_2021_sharing_microbes_humans
	Assignments from week 14 due Friday at 9 am: ➢ **Post-lecture comprehension quizzes on Brightspace (1 pt each)** ➢ **Take a Deep Breath Assignment (5 pts)**: Pick two very different animal species so you can compare two types of airways (lungs, gills, whatever insects have). I recommend searching for "lung microbiome animal" first and choosing a journal article for an animal that has had its lung microbiome characterized. Draw or find a diagram of the breathing anatomy of the first animal, and add details about interesting lung structure or function, and microbes found where. The second animal species can be any animal with a different anatomy for breathing you don't need to be able to find an article on their breathing anatomy and microbes. Draw, find a diagram, or describe the breathing anatomy of the second animal. How is the anatomy or physiology different between them? Are they moving air or water past their anatomy? What microbes are they likely to encounter in that air or water? Which of the microbes from air or water do you think would be able to persist in the lungs/breathing anatomy (it's ok if you can only find this info for the first animal). Includes any references you used. Text should be ¾ page, or >1 page if submitted >24 hours after the deadline, not counting the diagrams. Detailed instructions on assignment portal.
Week 15 12/7 – 12/11 Class on 12/7	*Lecture 27* "The problem with pollution." (40 min) How pollution in water and air is affecting microbiota and health. ➢ Post-lecture quiz ➢ **Reading after lecture (choose 1, or any other on water or air microbiomes):** ○ Allaire_2018_drinking water violations ○ Kumpel_2016_intermittent water supply ○ Pandey_2014_Contamination Water Resources ○ Stillo_2017_contaminated water health disparities ○ Tessum_2019_air pollution and racial inequity
	Lecture 28 "Biodiversity solutions." This lecture describes some of the legal frameworks that can be used to protect microbial ecosystems or specific microbes, as well as the scientific societies who are working towards stewardship and equitable access to microbes. I have selected examples of how researchers use microbiomes to help, either through microbial interventions (e.g. to resolve specific disease symptoms, to aid in conservation) or international research collaborations that coordinate global efforts (e.g. MSE, IUCN) Microbe Specialist group). You can also choose any example of microbial interventions from the semester to focus on. Watch the short

	lecture video, and then chose a reading topic: each of the readings has a paired short video and the paper it describes. Use it for inspiration on your final assignment for the class. ➢ There is no required post-lecture quiz ➢ **Video and Reading (choose a topic, or any other on conservation and microbiomes)**: ○ Jack Gilbert et al., Microbe Specialist Group IUCN ○ Harle, Huber et al., saga of soggy sauerkraut ○ Pauline van Leeuwen et al., microbiome in captivity and relocation ○ Malmuthuge, Guan, et al., calf microbiome interventions ○ Raquel Peixoto et al., probiotics, coral disease, and climate ○ Sue Ishaq et al., Microbes and Social Equity working group
	Assignments from week 15 due Friday at 9 am: ➢ **Post-lecture comprehension quiz on Brightspace (1 pt each, just one this week)** ➢ **Environmental Solutions Research (5 pts).** First, draw a concept map on microbes in the context of environmental exposures. Next, pick any example of how an environment affects an animal host, and how human land use or activities may negatively affect that ecosystem and that animal. You can use the same example that you used to create your Concept Map. Describe the environment, the animal, and how land degradation is affecting both. Be sure to explain how that environmental degradation could be negatively affecting microbes in that environment or host. Reimagine an aspect of the human ecosystem or activities that would resolve the issue, or which would support microbes in that environment and host. Explain your idea and roughly how it would work. Explain the process you would take to design, test, and re-design this new idea. Text should be 1 page, or >1.5 page if submitted >24 hours after the deadline, not counting the diagrams. Detailed instructions on assignment portal.
	Bonus content: "Now what? Careers in animal microbiomes" Where the field of host-associated microbiomes is headed, and relevant careers, what grad school is like. Featuring various speakers doing research around the globe. Optional follow-up readings and videos: You have the opportunity to add 'scientist' to the other identities you have, and you don't have to give up who you are to also be a scientist. These recorded guest lectures on Brightspace talk about integrated scientific and cultural/sexual/gender/socioeconomic identities.
Finals 12/14 – 12/18	**Last day of finals (Friday) at 9 am is the last day any assignment will be accepted. Since they are all late at this point, be sure to write extra content.**

There is always someone on campus to help you

My door is always open and I am always willing to help students, however, as a university employee I am also required to keep the community safe by disclosing information on crimes. This means I am a "mandatory reporter". If you disclose something to me, including in assignments, I am obligated to provide this information to the campus Title IX office. The Title IX Office will contact you discretely, and offer you support services, guidance, and help you choose if you want to take action.

For confidential resources on campus: Counseling Center: (207) 581-1392; Cutler Health Center: (207) 581-4000; Rape Response Services: 1-800- 871-7741; Partners for Peace: 1-800-863-9909.
For support services on campus which may have to report the incident to others who can help: (Emergency and non-emergency) Title IX Student Services, (207) 581-1406; (emergency and non-emergency) University of Maine Police: (207) 581-4040 or 911; (non-emergency) Office of Community Standards: (207) 581-1409.

Support services off campus: Mabel Wadsworth Center, Bangor, provides reproductive health care, abortion, addiction help, etc.

Free food and clothing

Black Bear Exchange's Food Pantry; Old Town Crossroads Ministry; Library laptop and media loan

University Rainbow Resource Center

The Rainbow Resource Center located in Memorial Union, Room 224, empowers and increases the visibility of Lesbian, Gay, Bisexual, Transgender, and Queer (LGBTQ) people by promoting equality and inclusiveness. We strive to maintain an open, safe, and supportive environment for students, staff, faculty and alumni and provide educational opportunities, information, and advocacy services.

Pregnancy, lactation, and parenting

I am happy to provide accommodation for students based on pregnancy, lactation, and parental needs, as well as work with the Office of Equal Opportunities (E.O.). The state of Maine and UMaine policies allow students to breastfeed in any space, including in class. If a lactation space is required, please contact E.O. for arrangements. The Pregnant on Campus Initiative provides pregnancy and parenting resources in Orono.

University Veterans Education and Transition Services (VETS)

University of Maine's VETS Center serves student veterans as they apply to, attend and advance beyond UMaine. The Veterans Center connects student veterans with the resources they need to successfully transition from combat to classroom to career. This includes help navigating the admissions process, applying for financial aid and U.S. Department of Veterans Affairs education benefits, academic assistance and preparing to re-enter the workforce. The VETS Center is located in Room 143 of the Memorial Union.

University Counseling Services

If you are experiencing a mental health emergency: Dial 911. You can also call campus Police Services at (207) 581-4040. For urgent help, check here for your options. Over the course of our time at the University, we may face a variety of concerns – depressed mood, anxiety, stress, family concerns, body image, substance use, sexuality and many others – that may interfere with their ability to focus on their studies. Counseling Services provides mental health and social support for all currently enrolled students. Staff follow strict legal and ethical guidelines concerning the confidentiality of counseling. Counseling services is located in Cutler Health Center, Room 125, by phone at (207) 581-1392.

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